MONTHLY WEATHER REVIEW,

MAY, 1877.

WAR DEPARTMENT,

Office of the Chief Signal Officer,

DIVISION OF

TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE AND AGRICULTURE.

INTRODUCTION.

The present REVIEW for the month of May depends upon all data received up to the 15th of June from the Canadian Metcorological Service, the United States Signal Service and Voluntary Observers, the Army Post Surgeons and the United States Navy. The most interesting features of the month have been:

First, The remarkably high temperature from the 18th to the 24th;

Second, The heavy rain-fall west of the Mississippi and the drought in California; also the light rains in the Lake region, and the forest fires in Michigan and New York;

Third, Injury done to grasshoppers in the West and Southwest by cold and rainy weather;

Fourth, The earthquake of Iquique, and the ocean wave resulting therefrom, also similar wave on the 15th on Lake Erie;

Fifth, The aurora of the 28th; and,

Sixth, Tornadoes and hail-storms in New York and New England on the 18th.

BAROMETRIC PRESSURE.

In General.—The general distribution of atmospheric pressure is shown by the isobars upon chart No. II; these present no marked resemblance to those of May in any of the preceding five years but agree better with the average or normal values. The barometric pressure has been decidedly low at the Rocky Mountain stations and in Oregon. By comparison with a chart of average mean pressures for May for the years 1872 to 1876, inclusive, it will be seen that during the present month the isobar of 30.00 has extended northward over the Lake region, or 12° of latitude north of its average position in Tennessee and Virginia. The area of pressures lower than 29.85 has, during the past month, been well developed on the eastern slope of the Rocky Mountains, and the same isobar crosses New Brunswick and Nova Scotia at an unusual distance inland. Barometric pressures have, therefore, been below the average in northern New England and the Canadian Provinces, but above the average in the Lake region.

Barometric Range.—The general range of the barometer over the whole country east of the Rocky Mountains was about 1.25 inches, as may be seen from the following table, which gives the maximum and minimum pressures that occur on the tri-daily maps (7:35 a. m., 4:35 p. m. and 11 p. m., Washington time,) near the centres of the respective areas of high and low barometer:

LOW AREAS.				HIGH AREAS.			
No.	Location.	Date.	Minimum Barometer.	No.	Location.	Date.	Maximum Barometer.
I.	Gulf of St. Lawrence	May 3rd, 4:35 p. m.	29.24	I.	Texas	May 1st, 7.35 a. m.	30.19
II.	Tennessee	May 3rd, 4:35 p. m.	29.70	II.	Manitoba	May 7th, 7:35 a. m.	30.25
III.	Texas	May 3rd, 4:35 p. m.	29.65		Lower Lakes	May 12th, 7:35 a. m.	30.40
IV.	Dakota	May 5th, 7:35 a. m.	29.44		South Atlantic States	May 15th, 7:35 a. m.	30.40
V.	Ohio valley	May 6th, 7:35 a. m.	29.35	III.	Manitoba	May 24th, 7:35 a. m.	30.37
VI.	Ohio valley	May 7th, 4:35 p. m.	29.57		Middle Atlantic States	May 28th, 7.35 a. m.	30.35
	Halifax	May 10th, 7:35 a. m.	29.63				
VII.	South Atlantic coast	May 7th, 11 p. m.	29.58				
VIII.	Manitoba	May 15th, 4:35 p. m.	29.55				
IX.	Minnesota	May 17th, 4:35 p. m.	29.37				
X.	Key West, Fla	May 17th, 4:35 p. m.	29.81				
XI.	Minnesota	May 25th, 11 p. m.	29.27				
XII.	Minnesota	May 31st, 4:35 p. m.	29.15				

The greatest local barometric ranges have been as follows: Bismarck, 1.29 inches; Breckenridge, 1.14; North Platte, 1.12; Yankton, 1.05; Duluth, Eastport and Mt. Washington, 1.01. *The smallest local barometric ranges* have been: Key West, 0.25; Santa Fe, .38; Galveston, .48; Indianola, .49; Cairo, Vicksburg and Salt Lake City, .50.

Area of High Pressure.—No. I.—On the first day of May the pressure was highest over the Gulf States, and on the 2d extended thence northward to the Lake region, after which it subsided, drawing eastward to the Atlantic, and was followed by a very general depression. Heavy damaging frosts were reported on the morning of the 2d in central and southern Illinois.

No. II.—On the 6th, in the morning, rising barometer, with cooler northerly winds, pressed southward over Canada and the Lake region, and by the 7th, in the morning, the barometer had risen 0.35 in Manitoba, and was high from Dakota to the St. Lawrence valley. From this time on the pressure began to diminish slowly. On the 9th, in the morning, the area of highest barometer extended from the Upper Lakes southward to the Gulf of Mexico, and so continued until the morning of the 11th, at which time an area of 30.25 prevailed over Canada, the Lake region, Middle and South Atlantic States. The barometer rose slowly over this entire region, as also over New England during the next twenty-four hours, and on the 12th, 7:35 a. m., an area of 30.40, covered Upper Canada. This marked southeastward extension of the area of high pressure probably was also connected with a storm-centre still farther southeast, since the Marine Reports show on the 12th a heavy NE. gale, lasting 48 hours, in lat. 24° 38′, N., 66° 30′, W. The pressure now diminished slightly, and on the 14th, continued highest from Upper Canada to the South Atlantic coast, but had fallen decidedly in New England and west of the Mississippi. During the next twenty-four hours the barometer rose in the South Atlantic States, but fell elsewhere, and on the 15th, 7:35 a. m., the area of 30.40 covered the Carolinas, where it remained central, with slowly diminishing pressure, until, on May 21st, 7:35 a. m., it had disappeared, with the barometer at 29.90 to 95, which pressure was about the highest exhibited on that map, and appears to have prevailed over the entire Gulf of Mexico and Gulf States.

No. III.—The barometer rose rapidly in Dakota on the 21st, following in the rear of storm No. XI, and on the 22d, 7:35 a. m, the highest pressure 30 22, was reported in Manitoba. This area extended southward over the Mississippi valley, and on the 23rd, 7:35 a. m., the pressure of 30.35 prevailed north of Lake Superior and Minnesota, with a northerly gale in the Upper Lakes. The area of rising barometer continued extending south and east, during the 23d, 24th and 25th, and on the morning of the 26th, the highest pressure, 30.26, was central over the Upper Lake region, whence it moved slowly southeastward, and on the 27th, 7:35 a. m., the area of 30 22 was central in the Ohio valley. This area now advanced eastward, and the central pressure now rose decidedly, so that on the 28th, 7:35 a. m., the area of 30.35 was central in Maryland, and on the 29th, in the morning, the pressure of 30.30 prevailed off the New Jersey coast. The central highest pressure continued over the Middle Atlantic States during the 29th and 30th, but the barometer fell steadily here, as it did, in fact, throughout the whole country, while the formation of low pressure, No. XII, was in progress. The area of 30 10 was central on the morning of the 31st over the Carolinas, but the pressure rose during the rest of the 31st, in the Gulf States, as soon as low barometer No. XII began to move northeastward, and on June 1st, 7:35 a. m., the highest pressure, 30.22, was over North Carolina.

Areas of Low Pressure.—But few well-defined areas of low pressure are charted upon map No. I. since, out of the twelve that are mentioned in the text, only the tracks of five could be satisfactorily given. Most of those that are charted lie somewhat southward of the average positions in former years. Their history in detail is as follows:

No. I.—First appears some distance off the New England coast, on the morning of the 1st, and during the 2d rapidly assumed the proportions of a severe cyclone, which seems to have passed northward over Labrador. The report of heavy NNW. gales for three days preceding May 1st, at the Bermudas, suggests that this cyclone must have moved slowly northward, passing a little to the east of those islands.

No. II.—This depression originated on the 2d in Kansas and Texas, whence it passed eastward, and was dissipated on the 3rd in the Ohio valley.

No. III.—This depression had the same origin as No. II; but in its eastward course kept near the Gulf coast, and was dissipated on the 4th in the East Gulf States.

No. IV.—This depression appears on the 4th and 5th, extending from Manitoba southeastward over the Nothwest, very generally accompanied by light rains. As it extended southward the rain-area extended over the entire Gulf States and the Ohio valley, giving rise to several centres of slight depression.

No. V.—The very general rains that prevailed in the Gulf and Atlantic States on the 4th and 5th gave rise, as aforesaid, to several slight depressions, one of which, No. V, moved eastward over the Alleghanies on the 5th. This storm has been charted as though it continued its course east of the Atlantic course and subsequently developed in the severe storm which was off the Nova Scotia coast on the 7th. The Marine Reports, however, make it likely that No. V, after crossing the Alleghenies on the 6th, united with the tornado that passed over St. Marks, Fla., at 2 p. m., and subsequently with a severe storm then existing over the Gulf stream. Thus, reports from lat. 35° 53′ N., 68° 19′ W., show that a destructive SW. hurricane prevailed in that locality on the 6th.

No. VI and VII.—The general depression which prevailed during the 5th west of the Mississippi extended somewhat eastward during the 6th, and is considered as the origin of low barometer No. VI. This was on the morning of the 7th central in Illinois and Indiana, and on the afternoon central in southern Ohio, at which time also a second depression (No. VII) was developing off the South Atlantic coast, and a third off the New England coast, which latter it may possibly be proper to consider as a continuation of storm No. V. The two areas, No. VI and VII, merged into one on the 9th, which was central at 11 p. m. of the 8th off the North Carolina coast. During the 9th, its course was apparently northeastward towards Nova Scotia, along the coast of which province it passed on the 10th, and then disappears from our chart. There was at this date a severe storm in the southern part of Great Brittain, but as no other storm-centre appears on the European Weather Maps until the 16th, it is probable that storm No. VI did not advance to Europe.

Nos. VIII and IX.—West of the Mississippi the barometer continued low during the greater portion of the time from the 9th to the 16th; but this condition, which is the normal one for this region at this time of the year, gave rise principally to local storms, (on the 11th at Brownwood, Texas, a destructive rain and hail-storm; on the 16th, tornado at Fulton, Mo.,) which, increasing day by day in severity, finally culminated in a heavy rain-fall and local storm in eastern Kansas on the 16th, and the small depression, No. IX, which, starting on the 15th in northern Dakota, stretched along the northern limit of our maps and on the 18th appears as a well-defined area of low pressure central in the St. Lawrence valley; it moved thence southeastward over Nova Scotia and disappeared on the 19th. When central, on the 18th, in the St. Lawrence valley the warm SW. winds that prevailed over New England and New York were attended by severe local storms as follows: Violent hail and thunder at Stanstead, Vt., and in northwestern Rhode Island; tornadoes near Quebec, at St. Hippolyte, Can., and Stuyvesant, N. Y. The most violent of these tornadoes passed to the north of the latter; its track is traced from Saratoga county southeastward through Argyle, in Washington county, N. Y., to Shaftsbury, in Bennington county, Vt.

No. X.—The barometer fell decidedly during the 16th and 17th in southern Florida, while an area of high pressure extended eastward over the South Atlantic States. The heavy rains and brisk winds seemed to show that a slight disturbance advanced westward over the Gulf of Mexico from that date to the 19th; but no definite track of its course can at present be given.

No. XI.—The permanent low pressure on the eastern slope of the Rocky Mountains culminated on the 19th in the formation, in Dakota, of a progressive area of low pressure, which was central on the morning of the 20th in eastern Dakota, but in the afternoon in southern Minnesota; it passed slowly northeastward over the Upper Lake region, being central in the afternoon of the 21st in Wisconsin, then stretched eastward over the Middle States and New England, and was on the morning of the 22nd central near Long Island. The first part of the course of this area of low pressure was as usual southeastward down the Missouri valley, and floods were produced on the 20th and 21st in the Missouri and Kansas rivers. Very destructive tornadoes on the 20th passed over Marion, Ind., and Blackearth, Wis.

No. XII.—An area of high pressure occupied the Lake region and Mississippi valley during the rest of the month, but on the 27th the pressure began to diminish west of the Mississippi, and from the 28th to the 31st a well-marked area of low pressure remained permanently central in Dakota, with steadily diminishing central pressure, and on its south and east sides an increasing area of brisk and high southerly winds and local rains, (amounting sometimes to incipient tornadoes at Sioux City, Iowa, and St. Paul, Minn., on the 30th, and in Lafayette county, Mo., on the 31st.) On the afternoon of the 31st the central area, whose pressure had fallen to 29.15, began moving eastward into Minnesota, and probably disappeared during the first few days of June in British America.

Vessels experiencing storms at sea.—The following notes relating to storms at sea have been received: On the 1st, heavy NW. gales for three days off Bermuda, probably the same as storm No. I; on the 6th a destructive hurricane from the SW. was experienced in lat. 35° 53′ N., long. 63° 19′ W.; on the same date, in same latitude, heavy NW. gale, possibly the same as storm No. V; on the 12th heavy NW. gale for 48 hours in 24° 38′ N., 66° 30′ W.; on the 16th strong S. and ESE. gale in 27° 32′ S., 49° E.

TEMPERATURE OF THE AIR.

In General.—The general distribution of temperature is shown by the isotherms on Chart No. II, from which it will be seen that the isotherm of 75° passed from central Texas eastward through the northern portion of the Gulf of Mexico and over the central portion of the Florida peninsula. The isotherm of 45° skirts along the coast of the Gulf of St. Lawrence from Cape Breton to the Saguenay. Mean temperatures at special points have been: Mt. Washington, 32°; Pike's Peak, 18°; Portland, Or., 57°; Portland, Me., 56°; San Diego, 60°; Charleston, 69°; Brownsville, Texas, 81°; Pembina, 57°. A comparison with the mean temperatures at the same stations since 1870 shows temperatures above the average in Minnesota, the Lake region and New England, but below the average in the Lower Missouri and Ohio valleys, and the South and Middle Atlantic States.

Maximum and Minimum Temperatures.—Maximum temperatures above 91°: 92° at Baltimore, 18th; Fort Gibson, 23rd; Indianola—Memphis, 22nd; New Orleans, 23rd; Concho, 27th and 30th. 93° at Denison, 23rd; Pittsburgh, 19th; St. Marks, 23rd; Fort Whipple, 19th. 94° at Augusta, 22nd; Knoxville, 18th; Lynchburg, 19th; Mobile, 23rd; Savannah, —th. 95° at Corsicana, 21st; Montgomery, 22nd; Vicksburg, 23rd; San Antonio, 26th. 96° at Jacksonville, 23rd; Norfolk, —th; Washington, 18th; Uvalde, —th. Minimum temperatures below 34: 33° at Chicago, 2nd; Grand Haven, 1st and 2nd; Pittsburgh, 3rd; Toledo, —th. 32° at Albany, —th; Bismarck, 3rd; Buffalo, —th; Cleveland, 1st; Denver, 6th; Detroit, 2nd; Erie, —th; North Platte, 7th; Rochester, 3rd. 31° at Breckenridge, 4th; Burlington, 5th; Dubuque, 1st; Indianapolis, —th; La Crosse, 1st; Morgantown, 3rd; Yankton, 1st. 30° at Milwaukee, 2nd. 29° at Port Huron, 2nd; Santa Fe, 4th. 27° at Alpena, 2nd; Cheyenne, 6th; Duluth, —th; Pembina, 1st. 26° at Marquette, —th; Virginia City, 6th. 24° at Escanaba, 1st. 11° at Mt. Washington, 3rd. 1° at Pike's Peak, 6th.

It will be seen that a remarkable interval of high temperatures prevailed from the 17th to the 23rd over a great part of the country east of the Mississippi, during which time the area of high barometer No. II was receding southeastward over the Atlantic States, and low barometer No. XI was moving eastward towards and over the Lake region.

Ranges of Temperature.—The largest diurnal ranges are as follows: 37° at Breckenridge, 24th; Dodge City, 1st; Eastport, 29th; Santa Fe, 28th; 38° at Denver, 8th; Port Huron, 19th; 39° at North Platte, ——; Boerne and Uvalde, 1st; 40° at Pembina, 24th. The largest monthly ranges have been: 56° at Alpena, Dubuque, Knoxville, Port Huron, Washington, Uvalde; 57° at Indianapolis; 59° at Morgantown; 60° at Pittsburgh; 64° at Marquette. The least monthly ranges have been: 33° at Cape Hatteras and Indianola; 34° at Cape Lookout and Pike's Peak; 35° at Cape May; 32° at Galveston; 27° at Key West and San Francisco.

Frosts have been reported as follows: 1st, Ind., (severe,) Ky., Ala., Ga., Ill., Iowa, Kan., Miss., (last,) Mo., Nebr., N. C., (severe,) Ohio, Tenn., Tex., Va., Wis. 2d, Ohio, Mich., Ind, (severe,) Tenn., Ky., Ga., Ill., Iowa, Mass., N. Y., N. C., (severe,) Penn, Tenn., Utah, Va., W. Va., Wis. 3d, Mich., Conn., Del., Ill., Ind., Iowa, Me., Md., Mass., N. J., N. Y., N. C., Ohio, Penn., Tenn., Va., W. Va., Wis. 4th, Ind., N. Mex., Mich., Ohio, Colo., Del., Ill., Mo., Nebr., N. J., N. Y., Penn., Vt., Wis. 5th, Conn., Mich, Del., Kan., Me., Md., Mass., N. H., N. J., N. Y., Penn., Vt. 6th, Me., N. H., N. Y., Penn., Utah. 7th, Neb., Dak., Conn., Iowa, Kan., (severe,) Md., Mass., Mich., N. H., N. Y., Penn. 8th, Me., Ill., Iowa, Kan., N. H., N. Y. 9th, Ill., Ind., Iowa, Mich., N. Y., N. C., Ohio, Tenn., Wis. 10th, Ohio, Ill., Ind., Iowa, Me., Md., Mich., N. C., (killing,) Penn., S. C., Tenn., Utah, Va., Wis. 11th, Me., Ohio, Del., Ind., Mich., N. C., Penn., Vt., Va., W. Va., Wis. 12th, Del., Ind., Me., N. J., Ohio, Penn., Vt., Wis. 13th, Mich., Ohio, Penn., Vt. 14th, Wyo., Me., N. Y., Ohio. 18th, N. Mex. 20th, N. Mex. 21st, Me., Ill. 22d, Ill. 23d, Mich., Ill., Utah, (severe,) Vt., Wis. 24th, Ill., Ind., Iowa, Mich., N. Y., N. C., Ohio, Penn., Va., Wis. 25th, Ind., Ill., Iowa, Md., (heavy,) N. J., N. Y., Ohio, Va., Wis. 26th, Mich., Ill., Ind., N. C., Ohio, Va. 27th, Ill.; N. Y. 28th, N. Y., Vt. 29th, N. Y., N. C. 30th, N. C. 31st, N. Mex.

Ice.—The formation of ice, rather than frosts: 1st, N. C.; 2nd, N. C.; 3rd, Conn., W. Va., Mass.; 10th, N. C.; 25th, Va.

PRECIPITATION.

In General.—The general distribution of rain and melted snow for May, is shown on chart No. III, from which it will be seen that the region of largest rain-fall extends from central Texas northward to Manitoba, with small areas of large rain-fall in southern Florida and the coast of the Canadian Provinces. This distribution of rain-fall for May appears to be quite anomalous, nothing similar having occurred during the last six years, the nearest approach to it being May, 1874, when narrow belts of heavy precipitation extended from Indian Territory to Lake Huron and also along the Atlantic coast; as a consequence the rain-fall west of the Mississippi is largely in excess of the normal values; on the other hand a large deficiency is reported from the Gulf and Atlantic States, the Ohio and St. Lawrence valleys and the Lake region. A

deficiency is also noted in the greater part of California, which, by the 10th of June, had caused a severe drought in many sections, although sufficient fell on the west slopes of mountain ranges.

Heavy Special Rains.—Dodge City, 24th and 25th, 2.15 inches. Denison, 2nd, 2.07. Duluth, 19th to 21st, 4.30. Fort Sill, 19th and 20th, 2.83. Leavenworth, 16th, 2.40; 31st, 2.30. Omaha, rained more or less every day from the 10th to the 20th, inclusive, during which time 4.57 inches fell; 31st, 2.24. St. Paul, 30th and 31st, 3.31. St. Augustine, Fla., 27th, 10 a. m. to 28th 7 a. m., 6.50. Fort Snelling, Minn., 20th, 3.34; 30th, 4.30; 31st, 5.12. Golden, Col., 2nd, 5th and 6th, snow-fall 10¾. Belvidere, Ill., 20th, 1.03 rain-fall in twenty minutes. Manhattan, Kan., 19th 3 inches during the night. Creswell, Kan., 12th 3 inches; 18th, 3.23. Austin, Tex., 6th, 3 inches in the morning.

Small Monthly Rain-falls.—The following stations report less than 0.50 inches of rain during the month: San Diego, 43; San Francisco, 18; Eagle Pass, 43; Florence, 31; Tucson and Maricopa Wells, 41; Saugeen, 26; Yuma, 06; Salinas City, Cal., 0.20; Forsyth, Ga., 0.45; Palermo, N. Y., 0.40; Nile, N. Y., 0.45; Ruggles, Ohio, 0.25; Hudson, Ohio, 0.25; Salem, Ohio, 0 35; Franklin, Penn., 0.47; Tusculum, Tex., 0.51. (the smallest for many years;) Strafford, Vt., 0.4.

Large Monthly Rain-falls.—Rain to the amount of seven inches or more fell during the month at the following stations: Duluth and Fort Sill, 7.24; Leavenworth, 8.67; Omaha, 8.62; St. Augustine, Fla., 9.95; Fort Snelling, Minn., 14.48; Creswell, Kan., 11.81; Segwick, Kan., 16.37; Springfield, Mo., 8.55; Clear Creek, Neb., 10.87; Howard, Neb., 10.05.

Droughts.—Droughts, injurious to vegetation, have been reported as follows: Cal., droughts in the interior, but abundant rains on the coast side of the mountains. Fla., severe droughts, but crop not yet injured. Ill., strawberry crop shortened one-third by drought. Southern Ind., vegetation suffering for want of rain. Ohio, very dry, corn and oats need rain. Tenn., smallest rain-fall for many years, gardens are suffering. S. Car., (York Co.,) no rain throughout the month; crops all suffering.

Hail-storms.—Special notes of hail-storms have been received from 93 stations on 29 days, distributed as follows: On the 1st, N. Y.; 2nd, Kan.; 3rd, Tex.; 4th, N. Y.; 5th, Tex., S. C., Tenn., Mont.; 6th, Tex., Fla.; 7th, Ala., Tex.; 8th, S. C.; 9th, Nev., N. C.; 11th, Nev., Utah, Tex.; 12th, Tex.; 14th, Dak., N. C.; 15th, Minn.,Neb., Tenn.; 16th, Cal., Col., N. Y.; 17th, Iowa, Mass., Neb.; 18th, Neb., Cal., Conn., N. Y., R. I., Vt.; 19th, Dak., Tex.; 20th, Nev., Ind.; 21st, Nev., Ill., Md., N. J., Penn., Tenn., W. Va.; 22nd, Nev., Del., N. J., Penn., Neb., Tex.; 24th, Tex., N. Y.; 25th, N. J., N. Y., Col.; 26th, N. J., Penn.; 27th, Md., Neb., Tex.; 28th, Dak., Neb. Tex.; 29th, Ill., Kan.; Col., Dak., Neb.; 31st, Dak., Kan., Utah, Iowa, Minn,, Mo., Neb., Ill.

Large Hail-stones.—Among the cases of large hail-storms are the following: 3rd, terriffic and destructive storm near Mason, Tex., hail as large as a man's hand, crushing crops and killing thousands of sheep. 4th, near Mendon, Mass. 7th, in Sabine county, Texas, 2.6 in. diameter, 3 to 4 in. long. 14th, at Bismarck, Dak., hail-stones 1.7 in. long, 1 in. wide, (see Loomis, p. 131, fig. 54.) 18th, the local storms and tornadoes of the 18th, elsewhere described, were accompanied by large hail, as follows: Cranston, R. I., 1 in. in diameter; Pascoag, R. I., 1½ in.; Brookfield, Mass., 1 in.; Webster, Mass., 3 in.; Oxford, Mass., 4 in. Bennington, Vt., 5 in. 27th, 22 miles north of Mason, Texas, 3 to 4 in. diameter, crushing through roofs; at Fort McKavett, 1 in. diameter, very destructive.

Snow-fall.—Falls of snow have been reported as follows: 1st, Mich., Ohio, Wy., Ind., N. Y., W. Va., Penn., Mon.; 2nd, Wy., Col., N. Y., Va.; 3rd, Wy., Va., Mich.; 4th, Mon.; 5th, Wy., Col., Mon.; 6th, Wy., Col.; 7th, Mon.; 8th, Mon.; 9th, W. Va., Mon.; 10th, Me., Vt.; 12th, Wy.; 17th, Utah, Mon.; 18th, Utah; 19th, Wy., N. M.; 23rd, Nev.; 24th, N. J., N. Y., Mass., (4 inches in Berkshire county;) 29th, Nev.; 30th; Wy., 31st, Wy., Mon.

Rainy days.—The number of days during the month on which rain has fallen, as reported by the Signal Service observers, ranges from 5 to 17 in New England; 9 to 14 in the Middle Atlantic States; 5 to 14 in the South Atlantic States; 3 to 13 in the Gulf States; 5 to 15 in the Ohio valley and Tennessee; 6 to 11 in the Lower Lake region; 4 to 11 in the Upper Lake region; 9 to 27 in the Northwest; 8 to 22 at the Rocky Mountain stations; 3 in Arizona; 10 at San Diego; 1 at San Francisco; and 16 at Portland, Oregon.

Cloudy days.—The number of cloudy days during the month, as reported by the voluntary and army surgeon observers, ranges as follows: New England, 5 to 12; Middle States, 3 to 13; South Atlantic States, 0 to 8; Gulf States, 0 to 10; Tennessee and the Ohio valley, 2 to 13; Upper Lake region, 1 to 9; Northwest, 2 to 18; Colorado, Wyoming, Utah and Idaho, 4 to 9; California, 1 and 2.

RELATIVE HUMIDITY.

The average relative humidity for the month ranges from 69 to 75 per cent. at the stations on the immediate coast of North Carolina, New Jersey and New England; other stations in the Atlantic States,

54 to 69; Gulf States, 53 to 73; Ohio valley and Tennessee, 56 to 62; Lake region, 54 to 68; Northwest, 52 to 72; Rocky Mountain stations, (excepting Pike's Peak,) 33 to 61; Pacific coast, 65 to 73.

WINDS.

The prevailing directions of the wind are shown by the arrows on chart No. II, from which it will be seen that the south and southeast winds have corresponded throughout the interior of the country very clearly to the distribution of barometric pressure.

Total movements.—Largest: Pike's Peak, 17,483; Dodge City, 11,998; Cape Lookout, 11,598; Cape May, 10,357; Breckenridge, 10,301. Smallest: Portland, Or., 2,394; Lynchburg, 2,569; Shreveport, 2,771; Augusta, 2,955.

Highest winds.—The highest velocities in miles per hour have been: 126 at Mt. Washington; 84 at North Platte; 70 at Pike's Peak; 60 at Cape Henry and Duluth.

Local storms, tornadoes, &c., are reported as follows: 6th, a tornado passed over St. Marks, Fla., at 1:50 p. m., demolishing several houses, chimneys, &c.; another occurred in Sabine, Tex. 14th, a whirlwind at Eastport, Me. 18th, tornadoes at St. Hyppolite, Can., and near Quebec. The tornado of the 18th, passing from Saratoga co., N. Y., southeastward into Bennington co., Vt., was especially destructive at Argyle and Cambridge, N. Y., and Bennington co., Vt.; the average width of destructive winds and hail is said to have been less than 2 miles, and its length about 50 miles; hail-stones of 5, 6 and 8 inches in circumference and weighing 4 ounces were picked up, and the very heavy rain accompanying it did additional damage; it began about 1 p. m., and probably ended about 3 p. m. in Vt. 20th, Marion, Ind. and Blackearth, Wis., severe storms. 21st, Key West, Fla. water-spout half mile NW. of station. 22nd, Wytheville, Va., severe wind-storm. 26th, Boerne, Texas, violent tornado. Sand-storm at Yuma, A. T., on the 28th, and "terriffic" sand-storm on the 29th. On the 16th to 19th the unusual occurrence is noted of a very heavy "Kona" storm and rain over the Sandwich Islands; heavy snow fell on the mountains, and a large water-spout was observed at Honolulu. (The "Kona" is a strong northerly wind, interrupting the regular NE. trade, and usually preceding a hurricane.) 30th, St. Paul, Minn., violent storm.

VERIFICATIONS.

Indications.—The detailed comparison of the tri-daily weather Indications with the telegraphic weather reports for the succeeding 24 hours shows a general percentage of omissions of 0.1 per cent., and of verifications of 85.9 per cent. Out of 3,713 predictions, 2,719, or 73.3 per cent., have been fully verified; 292, or 7.9 per cent., have been three-fourths verified; 459, or 12.4 per cent., have been one-half verified; 83, or 2.3 per cent., one-fourth verified; 160, or 4.4 per cent., have failed. The percentages for the four elements have been: Weather, 94.4; Wind, 87.5; Temperature, 84.1; Barometer, 77.6. The percentages of verifications by geographical districts have been: New England, 84.7; Middle Atlantic States, 87.0; South Atlantic States, 85.4; East Gulf States, 88.8; West Gulf States, 88.3; Lower Lakes, 86.4; Upper Lakes, 82.5; Tennessee and the Ohio valley, 87.9; Upper Mississippi valley, 83.7; Lower Missouri valley, 83.8.

Cautionary Signals.—During the month 83 Cautionary Signals have been displayed at stations on the Gulf and Atlantic coasts and the Lakes. Of these, 49, or 59 per cent., were justified by subsequent high winds within one hundred miles of the stations where they were displayed, and 34, or 41 per cent., were not justified so far as known. Fifty-one instances of high winds, when no signals were displayed, have also been reported from these stations. Telegraphic communication with the North Carolina coast stations has been interrupted during the month.

NAVIGATION.

Stages of Water.—In the table on chart No III is shown the highest and lowest readings on the river-gauges for the month. It will be seen that the lowest water in the Missouri and the extreme upper portion of the Mississippi occurred about the middle of the month, after which time these rivers rose until they reached their highest readings, at the close of the month. The lower portion of the Mississippi, as also the Ohio and its tributaries, and the Red river, all reached their lowest readings on the last day of the month. The Mississippi was slightly above the danger-line at Vicksburg from the 1st to the 23rd. At Keokuk, on the 28th, navigation was obstructed by the very low stage of water; also at Pittsburgh on the 29th. At Cambridge, Texas, on the 21st, water was very high in the Red river. At Indianola, on the 16th, tide was 8 feet higher than usual. At Leavenworth, destructive freshet on the 18th, and river very high on 20th. At Creswell, Marion county, Kan., highest flood for many years. At Sedgwick, Kan., on the 19th, river rose 23 ft. in 24 hours. At Hutchinson, and other towns in eastern Kansas, destructive freshet on the 20th, and subsequently.

Ice in Rivers and Opening of Navigation.—The most interesting feature under this head relates to the ice blockade in Lake Huron, which lasted from the 8th to the 15th, at St. Clair Flats, after having been open during the previous two weeks. At Fort Brady, Mich., ice was running in river from 7th to 14th. Navigation opened as follows: Erie canal, on the 8th. Marquette, 6th; heavy floating ice from the 1st to the 6th. The first vessel arrived at Oswego, N. Y., from Lake Michigan on the 11th.

TEMPERATURE OF WATER.

The temperature of the water in rivers and harbors is shown by the table on chart No. II. The highest temperatures are: 79° Savannah; 82° Augusta; 90° Key West. Lowest temperatures: 33° Eastport and Marquette; 36° Escanaba; 38° Duluth; 40° Alpena; 41° Detroit and La Crosse.

Largest Ranges.—27° La Crosse; 24° Grand Haven; 23° Cleveland and Keokuk; 22° Buffalo; 21° Pittsburgh; 20° Duluth and St. Paul.

Smallest Ranges.—3° San Francisco; 4° Eastport; 7° Chicago; 8° St. Paul; 9° Marquette; Portland, Me.

ATMOSPHERIC ELECTRICITY.

Thunder-storms or diffuse lightning are reported: 1st, Mass., Tenn.; 2nd, Col., Dak., Kan., Mo., Tex., Vt.; 3rd, Ind. Ty., La., Miss., Tex., Tenn.; 4th, Dak., Ill., Iowa, Ind. Ty., La., Mass., Miss., S. C., Tex.; 5th, Fla., Ga., Kan., Ky., Miss., N. C.; 6th, Fla., Ga., La., Miss., S. C., Tenn., Tex.; 7th, Ala., Fla., Ill., Miss., New Mex., Tex., (lightning;) 8th, Ind., N. C., Neb.; 9th, Dak., Md., Neb., Tex.; 10th, Col., Dak., Ill., Kan., Mo., Neb., Tex.; 11th, Ala., Fla., Ind. Ty., Kan., Tex.; 12th, Ala., Ga., Ill., Kan., La., Miss., Mo., Tenn., Tex., 13th, Col., Ga., Ill., Ind. Ty., Miss., Tenn., Tex., Utah; 14th, Col., Dak., Fla., Ill., Ind., Ind. Ty., Kan., Miss., Mo., Neb., N. C., S. C., Tenn., Tex., Wis.; 15th, Cal., Dak., Fla., Ill., Ind., Iowa, Mich., Minn., Mo., Neb., N. Y., N. C., Ohio, Penn., Tenn., Tex., Wis.; 16th, Conn., Dak., Ill., Iowa, Kan., Mass., Md., Me., Mich., Minn., Mo., Neb., N. J., N. Y., Penn., Tenn., W. Va.; 17th, Conn., Dak., Ill., Iowa, Mass., Me., Neb., N. J., N. Y., Penn., Wis.; 18th, Conn., Fla., Iowa, Kan., Me., Neb., N. Y., R. I., Tex., Vt.; 19th, Dak., Fla., Ga., Kan., Minn., Mo., Neb., Tex., Va.; 20th, D. C., Dak., Ill., Ind., Iowa, Kan., Ky., Md., Mich., Miss., Minn., Mo., N. C., N. J., Ohio, Penn., Tex., Va., W. Va., Wis.; 21st, Ala., Conn., D. C., Dak., Del., Ga., Ind., Kan, Md., Mich., N. C., N. J., N. Y., Ohio, Penn., S. C., Tenn., Tex., Va., W. Va.; 22nd, Conn., Del., Ga., Kan., Mass., Md., Mo., Neb., N. C., N. H., N. J., N. Y., Ohio, Penn., Tenn., Tex., Vt., Va., W. Va.; 23rd, Col., Dak., Fla., Kan., Me., Mo., N. C., Neb., Tex.; 24th, Col., Kan., Me., N. Y., Tex., Vt., Wyo.; 25th, Col., N. J., Tex., Vt., Wyo.; 26th, Fla., Neb., N. J., Penn., Tex.; 27th, Mo., Neb., N. J., Tex.; 28th, Conn., Dak., Minn., Miss., Neb., Tex.; 29th, Dak., Ill., Minn., Neb., Tex.; 30th, Col., Conn., Dak., Ill., Ind. Ty., Iowa, Kan., Mass., Mich., Minn., Neb, N. J., N. Y., Wis.; 31st, Dak., Ill., Iowa, Kan., Minn., Mo., Neb., Wis.

Telegraphic ground currents were reported at Santa Fe on the 23rd and 24th. Strong currents also prevailed in the Middle and Eastern States during the aurora of the 28th. At Pike's Peak on the 12th and 24th.

Auroras.—The auroras of the month of May have been more numerous and brilliant, and more extensively observed than for some years past. They have been reported from three hundred and thirty stations, on seventeen dates, distributed as follows, (the numbers following the name of each State express the number of reports received.) 1st, Iowa, 1. 2nd, N. J., 10; Mich., 7; Dak., 3; Mass., 10; N. Y., 7; Penn., 7; Va., 3; W. Va., 1; Conn., 3; R. I., 1; D. C., 1; Neb., 1; Ill., 1; Iowa, 2; Md., 3; Minn., 1; N. H., 2; Ohio, 2; Vt., 1; Wis., 4. 3rd, Mass., 2; Minn., 2; Mich., 3; Nev., 1; Mich., 1; Del., 1; Iowa, 1; N. H., 1; N. J., 1; Ohio, 1; Wis., 3. 4th, N. Y., 1; Mich., 1; Mass., 1. 7th, Kan., 1. 9th, Wis., 1. 10th, Me., 2; Mich, 1; N. J., 1. 11th, Mich., 2; Me., 3; N. H., 2; N. Y., 1. 12th, N. H., 1; N. Y., 1. 13th, Me., 1; Mass., 1. 16th, N. Y., 1. 18th, N. Y., 1. 21st, N. Y., 1. 28th, N. J., 12; N. Y., 25; Mich., 9; Mass., 14; Vt., 5; Ohio, 14; Ill., 8; Va., 6; Iowa, 40, of which 28 are due to the kind co-operation of Prof. J. Hinrichs; Penn., 8; Me., 7; Ind., 7; Tenn., 2; N. C., 2; Ky., 1; Wis., 2; W. Va., 1; N. H., 2; Conn., 2; R. I., 2; Mo., 1; D. C., 1; Dak., 1; Del., 1; Kan., 1; Md., 5; Minn., 1. 29th, Ohio, 2; N. Y., 4; Va., 1; Wis., 1. 30th, Me., 4; N. Y., 1; Wis., 1. 31st, Minn., 2.

The large number of reports relative to the brilliant aurora of the 28th, render this especially interesting. The following preliminary account is all that need at present be given. It was visible from Maine on the east to Kansas and Dakota on the west, and as far south as North Carolina and Kentucky. At Washington three arches were seen in the northern heavens, the altitude of the upper one being about 23°, with streamers to 45°. At Vevay, Ind., the arches rose to altitude 45° and streamers to zenith; the magnetic compass needles were in constant agitation, oscillating through an arc of 3°. Throughout eastern Iowa the heavens appeared illumined by streamers from the north passing to the zenith. At Cambridge and Waltham, Mass., arches reached to the zenith, and fragments formed to the south. At Grand Haven, Mich., the

streamers and light extended from east and west through the zenith. At Detroit, Mich., three arches were seen at altitudes of 45°, 65° and 90°; also a corona near the zenith, and streamers and light 10° south of zenith; the three arches were continually moving upward or southward and back again, reaching sometimes 15° south of zenith. At Adrian, Mich., two arches first appeared, then a third one at or south of z nith from E. to W.; similar phenomena was seen throughout Mich. In Connecticut streamers flashed near to the zenith. In Illinois and Indiana observers generally report no true arch, but only waves, clouds, and streamers of light. At Gardiner, Me., a beam from east to west reached the zenith. New Jersey two arches seen, the second indefinite and within the first. Central New York, arches from east to west through the zenith, and two or three others lower down towards the north; a fine corona was observed at Cazenovia, North Volney, Oneida and North Argyle; at New York city the altitudes of the arches were 45°, with streamers to the zenith. In Ohio telegraph lines were affected with ground currents, and one, and sometimes two perfect arches were observed, with streamers reaching to 75° altitude. Vermont, one of the most brilliant ever seen: corona was seen at Newport. Wisconsin, corona was seen at Manitowoc, Neillsville, and Rocky Run. The electric disturbance on telegraph wires was sufficient to interrupt the ordinary business between New York, Buffalo, Baltimore, Montreal and Washington.

OPTICAL PHENOMENA.

Solar Halos.—1st, Ind., N. J., N. Y.; 2nd, Ill., Ind., Iowa, Minn., Ohio, Wis.; 3rd, Del., Md., N. J., N. M., Ohio, Penn., Va., Vt.; 4th, Ga., Iowa, Me., Neb., N. H., Ohio, S. C.; 5th, Ind., Iowa, Mass., N. J., N. Y., Ohio, R. I., Wis.; 6th, Col., Conn., Me., Mass., N. H., N. Y.; 7th, Minn., N. J., N. M., Wy.; 8th, Conn., Iowa, Mass., Mich., Neb., N. H., Ohio., R. I.; 9th, N. Y.; 10th, Ala., Fla., Ill., Kan., Ky., Miss., N. Y.; 11th, Iowa, N. Y., Wis.; 12th, Conn., Ind., Iowa, Mass., N. Y., Ohio, R. I., Wis.; 13th, Ind, Me., N. J., Ohio, Wy.; 14th, Ala., Ind., Ky.; 15th, Ala, Dak., Ind., Iowa, La., N. Y., Ohio; 16th, Fla., Ind., Iowa, N. Y., Tenn., Wis.; 17th, Ga., Ill., Ind., Mass., N. J., N. Y., Ohio; 18th, Conn., Ill., Ind., Miss., N. Y., Ohio, S. C., Wis.; 19th, Conn., Fla., Ga., Ill., Ind., Mich., N. H., N. Y., Ohio, Wis.; 20th, Conn., Ill., N. J., R. I.; 21st, Me., N. H.; 22nd, Ill.; 23rd, Texas; 24th, Ala.; 25th, Neb.; 26th, N. H.; 28th, Conn., Ill., Me., Mich., Wis.; 29th, Neb.; 30th, Ill.; 31st, Conn., Mass., N. Y., R. I.

Lunar Halos.—2nd, Iowa, Mo.; 5th, N. Y.; 14th, Ind.; 15th, Iowa, Mich., N. J., Penn.; 16th, Ind., Ky., N. J., Ohio; 17th, Conn., Ga., Ill., Ind., Iowa, Me., Mass., N. J., N. C., Texas, Wis.; 18th, Ala., Ill., Ind., Iowa, La., Mich., Mo., N. J., N. Y., Tenn., Wis.; 19th, Del., Ind., Me., Mich., Minn., N. J., N. Y., Ohio, Penn., Texas, Utah, Va.; 20th, Miss., Mo., N. J., N. Y., Va.; 21st, Col., Mich., Mo., Texas; 22nd, Kan., Mo., Neb., Texas, Va.; 23rd, Iowa, Mo., Texas; 24th, Ala., Mo.; 25th, Minn.; 27th, Ga., Iowa; 28th, Fla.; 29th and 30th, La.

Mirage.—Tybee Island, Ga., 1st, 8th; Duluth, Minn., 8th, 23rd, 24th; New Bedford, Mass., 25th; Barnegat, N. J., 31st.

Scintillation of Stars.—No observations of scintillation have been received for May.

MISCELLANEOUS PHENOMENA.

Zoological.—Botanical.—The blooming and ripening of fruits only have been reported: *Apple* in bloom on the 5th in Conn.; 19th, Ga.; 7th and 13th, Ill.; 7th, 13th and 17th, Iowa; 19th and 31st, Me.; 16th, 17th and 21st, Mass.; 13th, Mo.; 2nd, Neb.; 4th, N. J.; 15th, N. H.; 21st and 30th, N. Y.; 6th, 7th, 8th, 13th, 14th and 15th, Ohio; 14th and 22nd, Penn.; 19th, Vt.; 18th, Wis. *Asparagus* ripe, 1st, Mass. *Cherry* in bloom, 1st, 7th, 11th, 12th and 13th, Mass.; 4th, Conn.; 14th, 15th and 18th, N. Y.; 1st, Ohio; 8th, Penn.; 16th, Vt; ripe, 22nd, Miss. *Currants* in bloom, 6th, Mass. *Peach* in bloom, 6th, Conn.; 3rd and 13th, Mass.; 19th, N. Y.; 2nd, 11th and 15th, Ohio; ripe, 30th, Texas. *Pear* in bloom, 4th, Ill.; 16th, Me.; 10th, 13th, 14th and 17th, Mass.; 17th, N. H.; 18th, 19th and 21st, N. Y.; 9th and 18th, Penn. *Plum* in bloom, 18th, Ill.; 11th and 13th, Iowa; 3rd and 13th, Mass.; 19th, N. Y.; 18th, Penn.; 15th and 18th, Vt.; 12th, Wis. Ripe, 22nd, Miss. *Quince* in bloom, 26th, Mass.; 9th, N. J.; 18th, Ohio; 19th, Penn. *Blackberries* in bloom, 20th, N. J. Ripe, 10th, Texas. *Almond* in bloom, 2nd, Neb. *Strawberries* in bloom, 1st, N. J.

Birds.—The first arrival and their migrations are reported as follows: *Blackbirds*, 3d, Kans. *Blue-jays*, 5th, Kans. *Bobolinks*, 18th, Iowa; 15th, Me.; 13th and 15th, Mass.; 14th, N. Y. *Cuckoos*, 19th, N. J. *Ducks*, 30th, Dak.; 19th, Mass., NW., and 22d, NE. *Geese*, 3d, 4th, 5th and 6th, Neb., N.; 15th, Minn., N. *Kingbirds*, 7th, Neb.; 12th, Ohio. *Martins*, 2d, Wis. *Night Hawks*, 16th, Iowa. *Orioles*, 1st, Me.; 10th and 14th, Mass.; 12th, Neb.; 12th and 15th, N. Y.; 12th, Ohio; 14th, Vt.; 17th, N. J. *Robbins*, with young, 15th, N. Y. *Swallows*, 7th, Me.; 6th, Mass.; 9th, Neb.; 1st, 14th and 16th, N. Y.; 3d, Ohio; 8th, Utah; 6th and 7th, Vt.; 14th, Virg. *Yellowbirds*, 8th and 10th, Mass.; 17th, N. Y. *Whippoorwills*, 19th, Iowa; 14th, Mass.; 1st, Ohio.

Insects.—*Grasshoppers*, flying at Camp Sheridan, Neb., N., 28th, NE., 29th; 2nd, still hatching out at

Cresswell, Kan., and at Corning, Mo.; 1st to 22nd, hatching out at Clear Creek, Neb.; at Howard, Neb., have hatched out during month, and, although heavy rains have destroyed many, they are still damaging crops; 27th, at Melissa, Tex., brought thither by W. winds; left same at noonday; Mesquite, Tex., (no date) damaging crops; 14th, Ft. Gibson, I. T., disappeared, drowned out by heavy rains; 29th, North Platte, flying N.; Omaha, injured by cold rains; many destroyed by the farmers; injuring crops somewhat; 28th, coming out of the ground at South Orange, N. J., 30th, appeared at Ardenia, N. Y.; 7th, 8th and 9th at Boerne, Tex., flying N., large swarm; 10th, all gone; 12th to 25th, Griffin, Tex., flying N., no damage done; Denison, Tex., hatched out rapidly the first three days in April; April 23rd, began moving and destroying; May 15th commenced flying northward, with southerly winds, their numbers steadily decreasing until the 26th, when they disappeared. *Colorado Beetles.*—Destroying potato crop at Milford, Ind.; doing much damage at Litchfield, Mich.; destructive at Auburn, N. H.; 16th, South Orange, N. J.; 6th, Starkey, N. Y., 13th, Morgantown, W. Va.; 20th, Flushing, N. Y.

FISHES.—*Sturgeon*, 3rd, Lower Brule Agency, caught in Missouri river.

Polar Bands.—Neb., Plattsmouth, 1st. Ohio, Carthagena, 2nd, 3rd, 12th, 13th, 18th, 23rd and 30th. Iowa, Monticello, 2nd; Guttenberg, 3rd and 25th; Iowa City, 4th, 10th, 26th to 31st; Nora Springs, 28th. Minn., Duluth, 3rd. Me., Eastport, 10th. Ky., Louisville, 17th and 31st. Ga., Tybee Island, 17th. La., Point Pleasant, 18th. N. H., Auburn, 23rd. N. Y., Waterburgh, 27th. Ill., Elmira, 28th. Va., Wytheville, 30th and 31st.

Sunsets.—The characteristics of the sky, as indicative of approaching fair or foul weather, have been observed daily at sunset at all Signal Service stations. The monthly means from 100 stations show that 74 doubtful cases, or blanks, were recorded, and that out of the remaining 2,712 cases, 2,158, or 79.5 per cent., have been followed by the expected weather.

Prarie and Forest Fires.—Near Wytheville, W. Va., 1st, 2nd; Oregon, Mo., 1st, 4th; Monticello, Iowa, 4th; Clear Creek, Neb., 4th, 9th; Brookhaven, N. Y. 7th; Wappinger's Falls, N. Y., 7th, 12th, 13th, 14th; Omaha, Neb., 8th, 9th; Marquette, Mich., 9th, 11th, 29th; Burlington, Vt., 11th; Eastport, 11th, 12th, 15th, 16th; Duluth, Minn., 12th; Grand Rapids, Mich., 13th; in northern New York, 12th to end of month; Alpena, Mich., and in New Brunswick, 14th; Portland, Me., 14th, 15th, 16th; Springfield, Mass., White Mountains, N. H., and Nile, N. Y., 15th; Mt. Desert, Me., and Adirondack Mountains, 16th; Fall River, Mass., 17th; Escanaba, Mich., 17th, 23rd, (town in great danger,) 29th, 31st; Portsmouth, N. C., 20th; 31st, for several days extensive forest fires have been raging in Marquette, St. Clair and Lapeer counties, Mich., and the towns of Onata, Schoolcraft county, and Greenwood, Ogemaw county, were entirely detroyed:

Meteors.—1st, North Volney, N. Y.; Jacksonburg, Ohio. 5th, Stockton, Tex. 10th, Jacksonburg, Ohio. 11th, Tybee Island; Lyndon, Ill.; Wilmington. N. C. 12th, Tybee Island; Salem, N. J. 17th, Breckenridge. 20th, Jacksonburg, Ohio. 21st, Leavenworth. 22nd, Oregon, Mo.; Embarass, Wis. 25th, Starkey, [illegible] Carthagena, Ohio. 29th, Monticello, Iowa.

According to the Simultaneous International Reports received at this office from Costa Rica, a feeble earthquake shock was experienced at San José, at 5h. 28m. a. m., local time, of the 10th, (or 6h. 24m. Iquique time,) and therefore 9h. 54m. after the occurrence of the shock at the place of its origin.

Concerning the earthquake and destroying destructive wave which spread over a great part of the Pacific ocean, the reports received are, in brief, to the following effect: About 8:30 p. m. several very heavy, destructive earthquake shocks occurred within four or five minutes throughout the region from Arica (lat. 18.°4 S.) to Mexillones, at the southern extremity of Bolivia, and apparently proceeding from a central region near the boundary between Peru and Bolivia, or near the volcano Llago, (Laguna? or Argua?.) The shocks were felt with less severity at Antofagasta, (possibly the town of that name in the Argentine Confederacy, lat. 26½° S., lon. 67½°,) and also throughout Chili and northern Peru. The shock was immediately followed by a great ocean wave, which began by a recession of the sea from the shore; this recession seems to have been going on during the continuance of the shocks. Within a few minutes after the last severe shock, and in some cases while fire-engines were being placed near the sea shore to obtain water for extinguishing the fires, the great wave suddenly dashed up over the shore, destroying everything within its reach. Among the details

reports that have been received are the following: Beginning at the central region, at the mouth of the river Loa, (lat. 21.5° S., lon. 22.5° W.,) we have, first, Cobija, (lat. 22.5° S.,) three-fourths of the town destroyed; wave 35 ft. high. Tocopilla, town obliterated. Mexillones, (lat. 23.1° S.,) town two-thirds obliterated; wave 65 ft. high. Coquimbo, (lat. 29.9° S.,) light shocks. Going northward we have, first, Pebillon de Pica, or Chavamazo, (lat. 21.2° S.,) town obliterated by the shock, fire and the water; many vessels injured in the harbor; the sea continued greatly agitated all night. Huanillos, town obliterated; wave nearly 60 ft. high. Iquique, (lat. 20.2° S.,) shocks about 8:30 p. m., exact interval from first to last 4 m. 20 sec., all proceeding from the southeast, and with great regularity; the whole town shaken down, burned with fire or washed away; the recession of the sea occurred, and the first great wave came in several minutes, possibly 10 minutes, after the first shock. Arica, (lat. 18.4° S.,) very numerous shocks, destroying all the fine buildings, followed by a recession of the sea, and then 8 successive waves, from 10 to 15 feet in height. Ilo, (lat. 1.6 S.,) partly destroyed by ocean wave. Callao, (12° S., long. 77.1° W.,) the first ocean wave felt at 11 p. m.; several distinct rises and falls were felt during the night; the highest rise, about 8 feet, occurred at 4 a. m., 10th. Anaheim, Cal., (lat. 33.8° N.,) ocean wave rose 12 feet in a few minutes. Gaviota, Cal., (lat. 34.4° N., long. 120.1°,) water rose and fell 12 feet three times in succession, between 7h. 10m. and 7h. 30m. a. m. San Francisco, (37.5° N., long. 122.5°,) first earthquake wave began 6h. 18m.; maximum wave of 14 inches rise and fall at 8h. 20m. a. m., with maxima one hour apart; five rises and falls of 9 inches occurred in 8 minutes, superposed upon the larger wave. Sandwich Islands, throughout these islands the waves were large and sometimes destructive. The time of the first wave is well fixed for Honolulu as 4h. 45m. a. m., at which time the tide ran out and returned in 12 minutes; in this time the observers at Oahu and Maui agree. At Hilo, further southeastward, the observer says the ebb began at 4 a. m., and the wave swept in at 5 a. m., and others kept coming in all day; at 7 a. m., a wave was timed and found to occupy 4 min. in going through an extreme rise and fall of 14 ft.; in the afternoon three successive waves were timed and the average gave for each, 20 min. in passing through its rise and fall of 10½ ft. The heights of the waves at the differerent islands are as follows: On Hawaii, 5 ft. at Kawaihie; 30 ft. at Kealakekua; 36 ft. at Hilo. On Maui, 6 to 12 ft. at Makee and Mamalua; 12 ft. at Lahaina; 22 ft. Kahului. On Oahu, 4 ft. 10 in. at Honolulu. On Kauai, 3 ft. at Naivailiwila. The volcano of Kilauea had exhibited unusual activity during the previous two weeks.

The following table gives the means of estimating approximately the velocity of the earthquake seawave in its passage over the Pacific Ocean:

Station.	Longitude.	Difference in time.	Arrival of Wave.		Interval.	Great circle distance.	Average velocity, hourly.
			Local time.	Normal time.			
	°	h.	h. m.	h.	h.	°	°
Origon	70.3 W	0.0	8 30 p. m.	8.5	0.0	0.0	—
Callao	77.1	0.5	First, 11 0 p. m.	11.5	3.0	11.5	3.8
			Max., 4 10 a. m.	16.5	8.0		1.4
Gaviota	120.1	3.3	7h. 10m. to 30 a. m.	22.6	14.1	73.8	5.2
San Francisco	122.5	3.5	First, 6 18 a. m.	21.8	13.3	76.0	5.8
			Max., 8 20	24.1	15.6		4.9
Honolulu	157.9	5.8	First, 4 45 a. m.	22.6	14.1	96.0	6.8

NOTES AND EXTRACTS.

Mr. S. W. Holman, of Boston, communicates to the Philosophical Magazine the results, as regards the air, of a new method of studying the relation between the viscosity and temperature of gases. As a result of his first experiments he says, it would appear that the viscosity of air increases proportionally to the 0.77 power nearly of the absolute temperature expressed in Centigrade degrees between the temperatures 32° and 212° Fahrenheit.

Mr. F. Guthrie describes a mercurial barometer of great sensitiveness, concerning which he states that the models he has made appear to succeed well. It consists of an ordinary vertical barometer tube, connected by a flat, horizontal, spiral tube of much smaller diameter, with a second short, open tube, corresponding to the short leg of a syphon barometer. A small bubble of air is visible in the spiral tube, dividing the mercury into two portions; the movement of this bubble is more rapid than the movement of the top of the mercurial column in the proportion of the area of the vertical and spiral tubes.

Observations on the relation between the weather and the twinkling of stars have been made for a number of years by Montigny in Belgium, and, as the result of observations on 230 evenings, with his scintillometer, he finds that the scintillations increase on the approach of a storm, especially of rain.

The direct use of the heat of the sun, instead of its indirect use, as a motive power continues to attract

much attention in France, and it is computed that in southern Europe, and still more so in tropical countries, it can advantageously replace wind-mills and water-mills, and possibly steam-engines in special cases.

With reference to the distribution of rain Pousset, of Poitiers, France, states that, in his department, he finds that the rain-fall is least in the most wooded districts, contrary to the generally received opinion.

With reference to the beneficial sanitary influence of eucalyptus globulus the reports from Algeria and Corsica unite in saying that, wherever the tree has been extensively cultivated, intermittent fever has been considerably decreased in intensity and in frequency.

Professor Viguier states as the result of his studies that the only requisites for the formation of hail-storms are, first, the existence of strata of air of different temperatures; second, the lateral translation of these strata, and, third, the presence of mountains. He excludes all reference to small cyclones and electric phenomena, and regards only the mechanical movements of the atmosphere and the effects of the inequality of the soil.

With reference to the measurement of rain-fall by means of gauges on board of ships, Lieutenant Henry Horkins states that he has compared two forms of marine rain-gauges, manufactured respectively by Casella and Negretti and Zambra, in both of which the receiving mouth of the gauge was kept nearly horizontal by supporting the apparatus on gimbals. He finds Casella's gauge slightly more trustworthy, although the differences between the two are but slight, except in windy weather. He recommends that two gauges be always employed on each quarter of the ship, and that the mean between their two indications be the accepted result.

From a series of observations on the accuracy of wet bulb thermometers under different conditions, Messrs. Marriott and Ward deduce the following conclusions as a contribution to hygrometry:

First. The accuracy of the apparatus depends most upon the kind of muslin and the conducting thread leading to the water reservoir: those thermometers having thick muslin read too high and are less sensitive; in calms, all wet bulbs read alike, but when a breeze springs up thin muslins will drop down a degree in a few seconds, while thick muslins and lamp-wicks require one or two minutes.

Second. The dry and wet bulbs should be of the same make and size—cylindrical bulbs are much preferable to spherical ones; it would be a great advantage if the muslin wrapping could be replaced in any way by a roughening or frosting of the glass bulb.

Third. The open water-reservoir should not stand near either bulb, otherwise they would be seriously affected, and the water cup should be covered over, having only a small orifice for the conducting thread; the wet bulb covering should be of very fine muslin or linen and changed once a month or oftener, and during very cold weather the muslin covering should be dispensed with, provided a proper coating of ice can be obtained on the naked bulb.

Fourth. When the muslin covering is to be changed the bulb should be cleaned by washing in dilute sulphuric acid.

In some remarks on the above communication, Mr. Whipple, of the Kew Observatory, called attention to a series of unpublished observations made at Kew in 1869, which showed that observations made with a delicate Regnault hygrometer gave dew-points agreeing very closely with those deduced from the readings of the dry and wet thermometers by means of Mr. Welsh's sliding rule, constructed on Apjohn's formula.

Mr. Marriott added that he had made observations with Dines' and Regnault's hygrometers, and that they agreed together very well; he thought that the simplicity of Dines' hygrometer was decidedly in its favor.

A very sensitive thermometer, invented and used for many years by Moritz, has been recently described by him. It consists essentially of a cylindrical band compounded of two strips of platinum and silver soldered together. One end of the band being fastened the other end is free to move with every change of temperature, and, in doing so, moves a mirror mounted upon an axis in such a way as to reflect to the observers' eye the divisions upon a fixed scale, as in magnetic observatories. The instrument, as used by Moritz, may be contained in a box of less than two inches on a side; it can be exposed to the weather if need be, and can, also, be used as a wet-bulb thermometer; it appears to be accurate to the fiftieth part of a degree, Fahrenheit.

The somewhat rare phenomenon of a fall of golden yellow snow occurred in the midst of a severe storm on the afternoon of the 27th of February at Peckeloh, in Germany. A specimen of the water melted from this snow, after being kept a few days, was microscopically examined by Weber, who describes it in Klein's Wochenschrift; he found that it contained principally four different kinds of germs or organisms, shaped respectively like arrows, coffee beans, horns and dark flat discs.

A monthly comparison of the weather in central Europe and northern America is published in the Annalen of the Hydrographic Bureau of Germany, from which it appears:

First. That in January, 1877, the barometric variations were very large in America in the first half of the month, but were large in Europe in the second.

Second. The large number of low-pressure areas and attending storms over both continents.

Third. The prolonged low temperatures of North America and the extraordinary high temperatures of Europe.

Fourth. The deficiency of rain-fall in America and its notable excess in Europe.

A remarkable fall of hail occurred in France on the 4th of April, 1877, and, according to the description in La Nature, these were uniformly of a conical shape, having round or hemispherical bases; then averaged over an inch in length and three-quarters of an inch in diameter. The sides of the cone were distinctly marked and the interior exhibited the usual concentric arrangements of its parts.

In a report of the commission of the Paris Academy of Sciences, the result of recent labors on the subject of the heat received from the sun is thus summarized: 1st, M. Crova, by means of observations of the pyrhliometer of Pouillet, and of the actinometer of Viola, has shown that the law of the intensity of solar heat as a function of the thickness of the atmosphere is represented by the hyperbolic formula

$\frac{m}{y}(c + m\ x) = \text{constant}$ where x is the thickness of the atmosphere traversed by the rays, y is the heat received by the observer, and c and m are constants. As to the quantity of the heat received normally at the upper limits of the atmosphere, it shows that it can scarcely differ from c calories per minute per square centimeter. Finally, Crova also shows that about one-twentieth more heat was received at Montpelier in 1875 than at Paris in 1874.

Viola has sought to determine the numerical value of the solar radiation, and to deduce therefrom the temperature of the sun, he, in order to determine the amount of heat absorbed by the earth's atmosphere, has made simultaneous observations with actinometers at different altitudes.

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